

PATENT APPLICATION

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TITLE OF THE INVENTION

"Piling Apparatus and Method of Installation"

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CROSS-REFERENCE TO RELATED APPLICATIONS

Priority of U.S. Provisional Patent Application Serial No. 60/248,349, filed 11/14/2000, incorporated herein by reference, is hereby claimed. This is a continuation in part of U.S. Serial Number 09/993,321 filed November 14, 2001 and incorporated herein by reference.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR  
15 DEVELOPMENT

Not applicable

REFERENCE TO A "MICROFICHE APPENDIX"

Not applicable

BACKGROUND OF THE INVENTION

20 1. Field of the Invention

The present invention relates to composite piling and more particularly to a piling apparatus that includes a helical anchor lower end portion to which a plurality of connectable sections can be added, each section having a hollow interior through which a drive member can pass, and each section being joined to another section at a joint that has a specially shaped fitting to be engaged by an enlarged portion of the drive member.

2. General Background of the Invention

30 Piling must often be installed in locations wherein a full size pile driving rig simply cannot be positioned. For example, if a building is having a settlement problem, piling must necessarily be driven below the building to

support its lower most structural aspect, such as the lowest concrete horizontal section or slab.

It has been known in the art to cut holes through the slab of a building and then install a screw type anchor or 5 screw type anchor piling system, in order to add support to an existing piling system that is already under the building. Once these additional piling have been placed, structural ties can be made between the building itself and the new piling.

10 Because pile driving equipment is not able to fit into the ground floor of existing buildings, a screw threaded piling or helical anchor is employed because it can be installed using a hydraulic rotary drive, for example. Such drive units are commercially available.

15 High capacity pile driving equipment is large and cumbersome to operate in confined areas. Conventional pile driving equipment can cause stress and fatigue on adjacent structures from weight and vibration.

Piles are used to support structures, such as 20 buildings, when the soil underlying the structure is too weak to support the structure. There are many techniques that may be used to place a pile. One technique is to cast the pile in place. In this technique, a hole is excavated in the place where the pile is needed and the hole is 25 filled with cement. A problem with this technique is that in weak soils the hole tends to collapse. Therefore, expensive shoring is required. If the hole is more than about 4 to 5 feet deep then safety regulations typically require expensive shoring and other safety precautions to 30 prevent workers from being trapped in the hole.

It is known to provide a cylindrical foundation support element having an open lower end and which may be rotatably driven into the ground by virtue of the

provision of an integral annular helix permanently affixed to the outer surface of the lower end of the support. The helix has an earth penetrating edge, and in conjunction with the cylindrical foundation defines an opening through  
5 which soil is allowed to pass into the chamber formed by the cylindrical wall of the foundation support. The opposite end of the cylindrical foundation support is adapted for releasable locking engagement to a drive element, which is used to rotate the support in a given  
10 direction, thus driving the support into the ground to a desired depth.

Langenbach Jr., U.S. Patent No. 4,678,373 discloses a method for supporting a structure in which a piling beating a footing structure is driven down into the ground  
15 by pressing from above with a large hydraulic ram anchored to the structure. The void cleared by the footing structure may optionally be filled by pumping concrete into the void through a channel inside the pile. The ram used to insert the Langenbach Jr. piling is large, heavy  
20 .. and expensive.

Another approach to placing piles is to insert a hollow form in the ground with the piles desired and then to fill the hollow form with fluid cement. Hollow forms may be driven into the ground by impact or screwed into  
25 the ground. This approach is cumbersome because the hollow forms are unwieldy and expensive. Examples of this approach are described in U.S. Patent Nos. 2,326,872 and 2,926,500.

Helical pier systems, such as the CHANCE™ helical pier system available from the A. B. Chance Company of Centralia, Mo. U.S.A., provide an attractive alternative to the systems described above. As described in more detail below, the CHANCE helical pier system includes a

helical screw mounted at the end of a shaft. The shaft is configured to draw the helical screw downwardly into a body of soil. The screw is screwed downwardly until the screw is seated in a region of soil sufficiently strong to 5 support the weight which will be placed on the pier.

Many piling systems have been patented that include multiple sections, some of which are provided with screw anchors or helical anchors.

An early patent is the Gray patent entitled "metal 10 Pile", U.S. Patent No. 415,037.

The Stevens patent 1,087,334, discloses and incased concrete piling.

A method for installing anchoring or supporting columns in situ is disclosed in U.S. Patent 3,354,657.

15 A piling that includes a cylindrical foundation support drivable into ground with a removable helix is disclosed in the Holdeman patent 5,066,168.

The Watts patent 3,422,629 discloses a construction support system and method and apparatus for construction 20 thereof. A helical member is part of the apparatus.

U.S. Patent 3,864,923 discloses a method and means for providing a pile body in an earth situs, including driving casing into situs to define a cavity of required depth. An auger positioned within the casing is rotatable 25 in screwing direction to remove earth from defined cavity, and carries expandible cutter means rotatable with auger to enlarge cavity girth below inner end of casing. Earth removed from casing and cavity enlargement is replaced with different material, such as self-hardenable cement, 30 to form pile body with load carrying enlargement at inner end of casing.

An earth auger is disclosed in U.S. Patent 3,938,344 in which an auger shaft is provided with freely expandible

and contractible rotary blades in such manner that said rotary blades may expand automatically when said auger shaft is rotated in the forward direction and may contract automatically when said auger shaft is rotated in the  
5 reverse direction. Also a method for driving piles and the like is disclosed which comprises the steps of positioning a pile or shoring adjacent to said auger shaft and above said blades, advancing said pile or the like into an earth bore excavated by said rotary blades, and filling said  
10 bore excavated by the rotary blades with mortar or the like.

The Turzillo patent 3,962,879 discloses a concrete pile or like concrete column formed in earth situs by rotating a continuous flight auger consisting of one or  
15 more sections into the earth to form a cavity of given depth; rotating the auger to remove augered earth from the cavity without removing the auger therefrom, and replacing the removed earth from the auger flights with fluid cement mortar, which hardens to form a column reinforced by the  
20 auger resultantly anchored in the same. A plurality of short auger sections may be connected together in succession during drilling to form a cavity of requisite depth by increments when low headroom conditions exist. A portion of the auger or a shaft portion without auger  
25 flighting thereon may also protrude above the earth situs for extension through water and the like and be filled with cementitious material which is allowed to harden. The method may also include first filling the auger shaft with the fluid mortar and allowing the same to harden in the  
30 shaft with a passage extending therethrough, and supplying more mortar through the passage to fill the cavity to form the column against backing of hardened mortar in the shaft.

The Vickars patent 5,707,180 discloses a method and apparatus for forming piles in situ. The '180 patent provides a method for making piles and apparatus for practicing the method. The piles may be used to support  
5 the foundation of a structure, such as a building. The method draws a soil displacer on a shaft down through a body of soil by turning a screw at the lower end of the shaft. The soil displacer forces soil out of a cylindrical region around the shaft. The cylindrical region is filled  
10 with grout to encapsulate and strengthen the shaft. The grout may be fed by gravity from a bath of grout around the shaft. The soil displacer has a diameter smaller than a diameter of the screw and may be a disk extending in a plane generally perpendicular to the shaft.

15 BRIEF SUMMARY OF THE INVENTION

The present invention provides an improved method and apparatus for forming piles in situ. The apparatus of the present invention includes a lower helical screw anchor to which are attached a number of add on sections.

20 The present invention utilizes a screw threaded piling or helical anchor because it can be installed in confined areas, using smaller and more agile equipment (such as a Bobcat® type skidsteer equipped with a boom mounted hydraulic powered high torque planetary auger drive made by Eskridge, for example). Such units as these  
25 are commercially available.

In the preferred embodiment, each section is in the form of a hollow member (eg. thin wall pipe such as .188" wall thickness or 0.125 wall thickness or Schedule 10 pipe) having a bore that receives a drive member or tool. The outer surface of each of the sections has soil displacing ribs that aid in pushing soil away from the sections as the pile apparatus is screwed down into the

earth. The hollow bore of each of the sections receives an elongated drive member. The drive member is comprised of connectable sections wherein each of the connectable drive sections is about the same length as each of the pile sections. An enlarged drive member is provided at intervals as part of the drive member, the enlarged section registering with a correspondingly shaped joint that connects two pile sections together.

The present invention provides an improved method and apparatus for installing an in-situ pile apparatus.

A lower helical anchor lead unit with variable size helical discs is screwed into the soil, followed by a conically shaped cutting and soil displacing unit. This unit has strategically placed (2-4) triangular ribs for cutting and displacing soil outwardly away from the sectional pipe sections. This same unit will work as a pile cap for concrete that is poured into upper pipe sections. With this improved shape, it cuts the soil when rotated. The upper flat round plate of the conical will work as a bearing plate to the soil.

Once the conical unit has reached the soil, a drive tool will be attached to the helical lead unit, connected with a plastic or wooden dowel placed through the typical bolt hole.

A formed (thin wall .188" or Schedule - 10 .125") pile section that has squared ends is placed over the drive tool and bolted to the conical unit. Silicone caulking can be installed at each square section makeup joint to prevent water or mud from entering the pipe sections.

A hydraulic planetary drive unit is attached to the square drive tool. The hydraulic auger driver unit is engaged and the helical anchor, conical unit, attached

pipe section(s) will be screwed downwardly into the soil. The hydraulic auger unit is then stopped and removed.

A second drive installation tool is bolted to the first. A second formed square sectional hollow form is placed over the drive tool and bolted. The hydraulic planetary drive unit is placed on top of the drive tool and the complete pile section is then screwed down into the soil until the top section reaches near ground level. This same process of installing drive tools and sectional hollow form units is repeated until the proper depth form has been reached (i.e. to satisfy the pile load requirements). As the complete pile unit is screwed down into the earth, the soil displacer ribs will push the soil outward away from the hollow pipe sections, creating less friction on the sections and therefore less torque.

With the proposed pile apparatus, the helical anchor will pull the hollow pipe forms down. At the same time the soil displacer ribs push the soil radially. This will allow the pile to penetrate deeper with less friction and a truer ft. lb. torque to capacity ratio. This method allows the pile to be installed as a point bearing pile, relying on the capacity of the helical discs that are screwed into the soil. In time, soil will reconsolidate around the larger diameter pipe forms which will develop a known friction capacity which will increase the overall pile capacity.

In one embodiment, a rod is provided that can be left with the pile section upon completion of installation to act as tensile rod or reinforcement for concrete that can be added to the internal bores of the various pile sections as connected end to end.

In another embodiment, plastic pipe sections can be added to the pile sections such as for example in water

installations, the plastic pipe sections extending between the mud line and water surface.

Other embodiments show various connectors for attaching the internal drive members together and for  
5 connecting the rod sections together.

#### BRIEF DESCRIPTION OF THE DRAWINGS

For a further understanding of the nature, objects, and advantages of the present invention, reference should be had to the following detailed description, read in  
10 conjunction with the following drawings, wherein like reference numerals denote like elements and wherein:

Figures 1A-1C disclose the preferred embodiment of the apparatus of the present invention, wherein Figure 1A fits the drawing Figure 1B at match line A-A and wherein  
15 the drawing Figure 1B fits the drawing Figure 1C at match line B-B.

Figure 2 is a schematic sectional elevational view of the preferred embodiment of the apparatus of the present invention illustrating a joint between two pile sections;

20 Figure 3 is a partial, perspective view of the preferred embodiment of the apparatus of the present invention;

Figure 4 is a sectional view taken along lines 4-4 of Figure 2;

25 Figure 5 is a partial perspective view of the preferred embodiment of the apparatus of the present invention illustrating the drive portion thereof;

30 Figures 6 and 7 are partial perspective views of the preferred embodiment of the apparatus of the present invention illustrating die members that can be used to form the joint that is at the end of each of the pile sections;

Figures 8 and 9 are plan and elevation views

respectively that illustrate the method of forming the pile joint sections;

Figures 10 and 10A are schematic illustrations showing the formation of the joint sections that are at 5 the end of each of the pile sections;

Figure 11 is a partial, perspective view of the preferred embodiment of the apparatus of the present invention;

Figure 12 is another partial, perspective view of the 10 preferred embodiment of the apparatus of the present invention;

Figure 13 is another partial, perspective view of the preferred embodiment of the apparatus of the present invention;

15 Figure 13A is a partial, sectional view of the preferred embodiment of the apparatus of the present invention showing drive tool removed and concrete added;

Figure 14 is a partial, perspective view of the preferred embodiment of the apparatus of the present 20 invention illustrating the hydraulic drive connected to the drive member, and showing an alternate construction that uses a hollow plastic section that is adapted for use in between a water bed and a water surface;

Figure 15 is a partial elevation, sectional view of 25 an alternate construction for the drive member;

Figure 16 is a sectional view taken along lines 16-16 of Figure 15;

Figure 17 is a sectional view taken along lines 17-17 of Figure 15;

30 Figure 18 is a partial, sectional elevation view illustrating an alternate construction for the internal drive member;

Figure 19 is a partial perspective view of the

connection shown in Figure 18;

Figure 20 is a partial, sectional elevation view illustrating the connection of Figures 18 and 19;

5 Figure 21 is a partial, perspective, exploded view illustrating the connection of Figures 18-20;

Figure 22 is a sectional, elevation view showing the system of Figures 18-21 after installation;

10 Figure 23 is a perspective view of another alternate embodiment of the apparatus of the present invention;

Figure 24 is another perspective view of an alternate embodiment of the apparatus of the present invention;

Figure 25 is a perspective exploded view of an alternate embodiment of the apparatus of the present invention;

15 Figure 26 is a plan view illustrating the die and forming apparatus for shaping the pile end portions for an alternate embodiment;

Figure 27 is an elevation view of the forming apparatus of Figure 26;

20 Figure 28 is a sectional view taken along lines 28-28 of Figure 27;

Figure 29 is a fragmentary view of the forming apparatus portion of an alternate embodiment of the apparatus of the present invention;

25 Figure 30 is another fragmentary view of the forming apparatus portion of an alternate embodiment of the apparatus of the present invention;

Figures 31-32 are schematic end views of a piling showing formation of the end portion of the piling section with the dies;

30 Figure 33 is a fragmentary elevation view of an alternate embodiment of the apparatus of the present invention illustrating the swaging machine;

Figure 34 is an end view of the swaging machine of Figure 33;

Figure 35 is a fragmentary side view of the swaging machine of Figure 33 illustrating a swaging of the end portion of the pile section;

Figure 36 is a partial perspective view of the swaging machine;

Figure 37 is a fragmentary perspective view of an alternate embodiment of the apparatus of the present invention illustrating a joint between the helical anchor and the pile section;

Figure 38 is a partial perspective view of an alternate embodiment of the apparatus of the present invention illustrating the pile driving tool and its connection to the pile section; and

Figure 39 is a partial perspective view of the alternate embodiment of the apparatus of the present invention illustrating the pile driving tool and its connection to the pile section.

## 20 DETAILED DESCRIPTION OF THE INVENTION

In Figures 1A-1C, the preferred embodiment of the apparatus of the present invention is designated generally by the numeral 10. It should be understood that in order to fit an entire elevation, sectional view of the apparatus 10 of the present invention on a single page, matchline type drawings are used wherein Figure 1A fits to the top of Figure 1B along matchlines A-A. Similarly, Figure 1C fits to the bottom of Figure 1B at matchlines.

30 In situ pile apparatus 10 includes generally a lowermost, first section in the form of helical anchor 11, a second section 12 which is a hollow pile form section, a third section 13 and a fourth section 14. The third and fourth sections 13, 14 are also hollow pile form sections. Each

section 12, 13, 14 has an internal bore. Section 12 has bore 28. Section 13 has bore 27. Section 14 has bore 26.

In the preferred embodiment, the sections 12, 13, 14 are preferably interchangeable pile sections. An internal 5 drive member 15 extends through a hollow bore of each of the sections 12, 13, 14. The drive member 15 has an upper end portion 16 to which a commercially available hydraulic rotary drive motor can be attached. The drive member 15 has a lower end portion 17 that forms an attachment with 10 an extension 18 at the upper end of helical anchor 11.

The drive member 15 can be comprised of a number of connectable sections as shown, including drive sections 19, 20, 21. Each drive section 19, 20, 21 provides a lower connector 22 (for example, a female connector) that forms 15 a connection with an upper connector 23 (for example, a male connector). The lowest drive section 19 provides a connector 22 that forms a connection with extension 18 of helical anchor 11 as shown in Figure 1C.

The internal drive 18 and member 15 is positioned 20 internally of pile sections 12, 13, 14 and occupying the respective bores 28, 27, 26 as shown in Figures 1A, 1B, 1C, 2, 4, and 11-13.

In Figure 2, an enlarged view shows the joint between 25 second section 12 and third section 13. It should be understood that a similar connection is formed between section 13 and section 14. In Figure 2, each of the sections 12, 13 has a plurality of circumferentially spaced radially extending soil displacing ribs 24. Soil displacing ribs 24 can also be seen in the plan view of 30 Figure 4. The drive section 19 carries an enlarge drive member as shown in Figures 2 and 5.

In Figures 2, 3, and 4, the details of a connection between a pair of pile sections is shown such as, for

example, between the second pile section 12 and the third pile section 13. In Figures 2-4, the pile section 12 has an upper end portion that provides an upper squared end portion 29. Similarly, the third pile section 13 provides 5 a lower square end portion 30 that has a socket 73 that is slightly smaller than the square end portion 29 so that the end portion 30 fits into the section 29 at socket 73 forming a snug fit therewith.

Each of the square end portions 29-30 provides a plurality of lugs. The upper square end portion 29 provides a plurality of lugs 31. The lower square end portion 30 provides a plurality of lugs 32. Each of the lugs 31, 32 provides an opening 35 through which a bolted connection can be placed as shown in Figures 1A - 1C, and 15 2-4. The bolted connections include a plurality of bolts 33 and a plurality of nuts 34 as shown.

As shown in Figure 2, the lower squared end portion 30 at the bottom of pile section 13 fits snugly into the socket 73 of upper square end portion 29 at the top of pile section 12. As shown in Figure 2, enlarged drive member 25 of internal drive member 15 closely fits and conforms to the assembly of upper square end portion 29 and lower end portion 30 as shown. Enlarged drive member 25 occupies the socket 74 at the lower end portion of pile section 13 (see Figure 2).

In the preferred embodiment, an enlarged drive member 25 is positioned at every joint between pile sections such as shown in Figures 1A-1B. However, it should be understood that any desired number of pile sections 12, 30 13, 14 can be added to configure or "make-up" a very long pile apparatus. As each pile section 12, 13, 14 is added, an additional drive section such as 19, 20, 21 is added, in each case an enlarged drive member 25 registering at

the joint between sections such as 12 and 13 as shown in Figure 2.

When bolting the helical anchor 11 to lower square end portion 30 of a pile section such as 12 (see Figure 5 11), the anchor 11 provides a round plate 36 having peripheral openings 75 through which bolts 33 can pass as shown in Figure 1C. For stiffening and soil cutting and soil displacement purposes, a plurality of radially extending triangular plates 37 are provided at the upper 10 end portion of helical anchor 11 just below plate 36 as shown in Figure 1C and 11.

In Figures 13 - 13A, the apparatus 10 of the present invention is shown after placement and wherein the bore 26, 27, 28 of each of the sections 12, 13, 14 is filled 15 with a suitable filler material such as concrete and rebar reinforcement. In such a case, the connection between the extension 18 of helical anchor 11 and the lower end portion 17 of drive section 19 is broken by simply pulling up on the various components of the drive member 15 to 20 shear pin (eg. wood or plastic) 38 (see Figure 13). At other locations such as the connection between drive section 19 and drive section 20, a strong bolted connection using bolt 39 and nut 40 can be provided as shown in Figure 5, passing through openings 41 in drive member 19 and opening 42 in drive member 20.

Figures 6-9 and 10A-10B show a die construction for forming upper squared end portion 29 and lower squared end portion 30. A pair of dies 43, 44 can be provided, the die 43 being used for forming the lower squared end portion 30 30 and thus having a longitudinal dimension A that is longer than the corresponding dimension B of die 44, and a transverse dimension C that is smaller than the transverse dimension D of die 44. The die 43 in Figure 6 forms the

smaller cross sectional, but longitudinally longer lower squared end portion 30 whereas the die 44 in Figure 7 forms the transversely wider but longitudinally shorter upper squared end portion 29.

5 Figures 8 and 9 illustrate formation of these end portions 29 and 30 using a hydraulic jack 45 to force corresponding pairs of these dies 43, 44 apart while support 46 has clamp members 47, 48 that securely hold sections 12, 13. The support 46 thus functions as a slide 10 top having runways 49, 50 that receive and track die supports 51, 52 that carry dies 43, 44 respectively.

In Figure 12, it should be understood that the helical anchor 11 can include a number of connected sections such as 11A, 11B connected together using bolted connections 39, 40 that are similar to the connections shown in Figure 5.

Figure 14 illustrates a system that can be used in water wherein a plastic cylindrical pipe section or sections 53 can be joined to an uppermost section such as 20 12, 13, 14 using rivets and/or glue. In such a situation, the pile section that is the upper most section (such as section 13 or 14 in Figure 1A) will be replaced with a transition section 54 having a circular connector 55 that receives the lower end portion of pipe section 53. The 25 internal drive 15 extends through the plastic pipe section 53 for connecting with hydraulic drive 56. As shown in Figure 14, more than one of the plastic pipe sections 53 can be employed, connected end to end and glued as is known in the art.

30 The embodiment of Figure 14 can be used in aquatic environments wherein the pipe sections 53 extend between the mud line and the water line and/or can be used in any corrosive environment.

Figures 15-17 shown an alternate arrangement for the internal drive member 15. In Figures 15-17, each of the internal drive members 15 is replaced with a specially configured drive member 57 wherein each of the drive members is hollow, providing a bore 58 that receives internally positioned rod 59. The extension 18 of anchor 11 is replaced with an extension 60 that has an upper end portion that is internally threaded at 61 to receive an externally threaded portion 62 at the lower end of rod 59 as shown in Figure 15. This construction enables the drive member 57 to be removed, leaving the rod 59 behind for reinforcement purposes.

Radially extending projections 63 on extension 60 stop the drive tool 57 from slipping down the shaft 60. Torque can be imparted from drive member 57 to extension 60 and thus to helical anchor 11.

In order to remove the internal drive member 57, the operator simply lifts the drive member 57 off the stops 63, disengaging the drive tool 57 from extension 60. Figures 18-22 show another arrangement for connecting internal drive member 57 to an enlarged drive member 25 as shown in Figures 19-21.

In Figures 19-21, a pair of steel pins 65 are inserted through openings 66 when the lower end 67 of a drive member section is to be connected to another drive member section. The drive member section 67 fits over the fitting 68 above enlarged drive member 25 and pins 65 are placed through openings 66 and under horizontal surfaces 69.

Figure 21 shows two (2) drive tool retainer clamps 70, 71 held together by the O-ring 72. The retainer clamps 70, 71 grip rod 59 and thus hold the shaft of the drive tool 57 to prevent it from moving up during installation.

once the drive tool 57 is installed, the clamps 70, 71 are removed.

Figures 23-39 show additional alternate embodiments of the apparatus of the present invention designated by 5 the numeral 102 in Figure 23, 102A in Figure 24, and 80 in Figure 25. Each of the piling apparatus shown in Figures 23-25 utilize a specially configured piling section having end portions that are not circular and so that they transfer rotation and torque, and that can be shaped using 10 the apparatus show in Figures 27-32. One of the piling apparatus 102 of Figure 23 has a swaged transition 113 that can be formed using the apparatus shown in Figures 35-37.

Each of the piling apparatus of Figure 23-24 can be 15 installed using hydraulic rotary driver 151 having drive tool 152 that engages one of the shaped end portions of the pile sections shown in Figures 23-25.

Piling apparatus 80 provides a lower, helical anchor section 81 that connects to cylindrical section 85 using 20 circular plate 82 and triangular plates 83. The connection of circular plate 82 to cylindrical section 85 can be a welded connection. Similarly, the connection of triangular plates 83 to circular plate 82 and to helical anchor 81 can be welded connections. The helical anchor 25 81 provides one or more helical blades 101 that embed the piling apparatus 80 into a selected soil medium when uppermost shaped section 97 is rotated using hydraulic rotary driver 151.

Piling section 89 has an upper shaped (e.g. squared) 30 non-circular section 86 provided with a plurality of lugs 95, each having an opening 96 through which a bolt can be attached when joining one more pile sections 89 together. Similarly, a lower squared section 99 has a plurality of

lugs 100, each having an opening 96 that receives a bolted connection 110. In Figure 25, the squared section 99 is a male section that fits squared section 86 of helical anchor 81. The squared section 86 provides lugs 87, each 5 lug having an opening 88 that accepts a bolted connection 110. The cylindrically shaped central section 98 of piling section 89 is an unformed portion of the piling section 89. Thus, the piling section 89 can begin as a cylindrically shaped section of pipe such as schedule 10 10 or schedule 20 pipe, for example.

Piling section 89 provides a hollow bore and has upper and lower end portions 91, 92. One or more helical blades 93, 94 can be provided on the cylindrical section 98 of piling section 89, being welded thereto for example. 15 A tapered transition section is provided and defined by plate 82, triangular plate sections 83, and the anchor shaft 111. In this fashion, the helical anchor 81 pulls the piling apparatus 90 into a selected soil medium when the apparatus 80 is rotated using hydraulic rotary driver 20 151.

In Figures 23 and 24, different transition sections are provided. Otherwise, the apparatus 102, 102A of Figures 23 and 24 is similarly driven into a selected soil medium using a hydraulic rotary driver 151. In Figures 23 25 and 24, piling apparatus 102, 102A includes a central cylindrically shaped section 103, upper end portion 104 and lower end portion 105. The upper end portion provides a shaped (e.g. squared) section 106 having lugs 107 with openings 108 that enable bolted connections 110 to be used 30 to join a piling section 89 to the piling apparatus 102, 102A showing in Figures 23 or 24. Anchor shaft 111 can be provided with one or more helical vanes 112.

In Figure 23, a swaged joint 113 is provided at lower

end portion 105. Additionally, a circular plate 114 can be welded at the joint between cylindrical section 103 and swaged joint 113. In Figure 24, anchor shaft 111 extends to and through plate 114, being welded to it. A second or 5 third or additional number of plates 114 can be positioned internally of cylindrical section 103, shaft 111 being welded thereto. Figures 26-32 show a fabrication device 115 that can be used to form the pile section 89 of Figure 25, a plurality of such pile sections being connectable 10 end-to-end and wherein a lower most of said pile sections 89 can be connected to helical anchor 81, pile apparatus 102, or pile apparatus 102A.

Fabrication device 115 includes a frame 116 that can be comprised of a plurality of transverse beams 117 and a 15 plurality of longitudinal beams 118. The transverse beams 117 can be anchored (for example, bolted) to an underlying floor 119 or other suitable support.

Rails 120 are provided on longitudinal beams 118 for support a first carriage 121 and a second carriage 122. 20 Carriage 121 has a pair of forming members 124, and 125, each being pivotally attached to first carriage 121 at pivot 123. Hydraulic cylinder 126 enables dies 129, 130 mounted respectively upon forming members 124, 125, to be moved together or apart. Hydraulic cylinder 126 can be 25 attached to forming member 127 at pivotal connection 127. Hydraulic cylinder 126 can be attached to forming member 125 at pivotal connection 128.

Each forming member 124 has a die. The forming member 124 has die 129. The forming member 125 has die 30 130 (see Figures 26-32). Second carriage 122 has the same construction as first carriage 121 with the exception of die members 129A, 130A being of different dimensions than the die members 129, 130. The die members 129, 130 are

used to form the male end portion of pile section 89 which is preferably a longer section. The die members 129A, 130A form the female end portion of piling section 89. The die members 129A, 130A are dimensioned so that when  
5 they form an end portion of pile section 131, the squared end portion 97 is a female section that is slightly larger than the squared end portion 99 that is a male end portion. Similarly, the squared section 86 is a female section that receives the squared end portion 99.

10 In Figure 26, an unformed pile section 131 is shown resting upon supports 132. Each of the first and second carriages 121, 122 is provided with one or more casters or wheels 133 that ride upon rails 120. As shown in Figures 31 and 32, unformed pile section 131 has a bore 134 that  
15 is cylindrically shaped prior to forming (Figure 31). The dies 129, 130 or 129A, 130A are expanded in the direction of arrows 135 (Figure 32) when forming a squared end portion to form pile section 89 or helical anchor 81. The formed squared section 136 as shown in hard lines in  
20 Figure 32 while the original cylindrical shape of unformed pile section 131 is shown in phantom lines in Figure 32.

Figures 33-37 show a swaging device 140 that can be used to form the swaged joint 113 shown on piling apparatus 102 in Figure 23. Swaging device 140 includes  
25 a support frame 139 for holding a section of conventional pipe or other unformed pile section 131 by grasping the cylindrical section 103 thereof. A plurality of shaped heads are mounted on pushrods 142 of hydraulic cylinders 143 that can be positioned about 90° apart as shown on  
30 Figure 34.

These four hydraulic cylinders 143 are simultaneously activated to extend pushrods 142 in the direction of arrows 144 to engage a squared, shaped end portion 136

that has been formed using the apparatus of Figures 26-32. The completed swaged joint 113 as shown on Figure 37 having a squared opening 153 that receives shaft 111 of pile apparatus 102. A weld can be used to join shaft 111 and swaged joint 113. Additionally, the folds 154 can be welded at the lower end portion of swaged joint 113 to provide additional strength. Additionally, one or more circular plates 114 can be welded inside of cylindrical section 103 and to shaft 111 for additional bracing and reinforcement.

Figures 38 and 39 illustrate a suitable connection that joins hydraulic rotary drive 151 to pile section 89. Drive tool 152 can be removably attachable to rotary driver 151 using connection 155 such as the projection and socket shown with bolted connection 156 to attain the connection 155. Drive tool 152 has an enlarged, square drive member 157 that fits a female squared end portion 97 of pile section 89.

Connector 145 includes four ell shaped portions 147, each having a pair of sleeves 148 with sleeve openings 149 for receiving bolted connections 150. By tightening the bolted connections 150, the squared end portion 97 closely conforms to square drive 157 and reduces the chance of deformation or damage to squared end 97 if an operator should apply too much torque to hydraulic rotary driver 151. The brackets 146 that include ell shaped portions 147 and sleeves 148 can be of welded steel construction for example.

#### PARTS LIST

The following is a list of suitable parts and materials for the various elements of the preferred embodiment of the present invention.

PART NO.

DESCRIPTION

	10	in-situ pile apparatus
	11	helical anchor, first section
	11A	anchor section
	11B	anchor section
5	12	second section
	13	third section
	14	fourth section
	15	drive member
	16	upper end portion
10	17	lower end portion
	18	extension
	19	drive section
	20	drive section
	21	drive section
15	22	lower connector
	23	upper connector
	24	rib
	25	enlarged drive member
	26	bore
20	27	bore
	28	bore
	29	upper square end portion
	30	lower square end portion
	31	lug
25	32	lug
	33	bolt
	34	nut
	35	opening
	36	round plate
30	37	triangular plate
	38	shear pin
	39	bolt
	40	nut

	41	opening
	42	opening
	43	die
	44	die
5	45	jack
	46	support
	47	clamp
	48	clamp
	49	runway
10	50	runway
	51	die support
	52	die support
	53	pipe section
	54	transition section
15	55	connector
	56	hydraulic drive
	57	internal drive member
	58	bore
	59	rod
20	60	extension
	61	internal thread
	62	external thread
	63	tool stops
	64	stops below drive tool
25	65	pin
	66	opening
	67	lower end
	68	fitting
	69	horizontal surface
30	70	retainer clamp
	71	retainer clamp
	72	O-ring
	73	socket

	74	socket
	75	opening
	76	concrete
	A	dimension arrow
5	B	dimension arrow
	C	dimension arrow
	D	dimension arrow
	80	piling apparatus
	81	helical anchor
10	82	circular plate
	83	triangular plate
	84	sleeve
	85	cylindrical section
	86	squared section
15	87	lug
	88	opening
	89	piling section
	90	hollow bore
	91	upper end
20	92	lower end
	93	helical blade
	94	helical blade
	95	lug
	96	opening
25	97	squared section
	98	cylindrical section
	99	squared section
	100	lug
	101	helical blade
30	102	piling apparatus
	102A	piling apparatus
	103	cylindrical section
	104	upper end

	105	lower end
	106	squared section
	107	lug
	108	opening
5	109	helical vane
	110	bolted connection
	111	anchor shaft
	112	helical vane
	113	swaged joint
10	114	circular plate
	115	fabrication device
	116	frame
	117	transverse beam
	118	longitudinal beam
15	119	floor
	120	vail
	121	first carriage
	122	second carriage
	123	pivot
20	124	forming member
	125	forming member
	126	hydraulic cylinder
	127	pivotal connection
	128	pivotal connection
25	129	die
	129A	die
	130	die
	130A	die
	131	uniformed pile section
30	132	support
	133	caster
	134	bore
	135	arrow

	136	formed, squared section
	137	pile support
	138	clamp
	139	support frame
5	140	swaging device
	141	shaped head
	142	pushrod
	143	hydraulic cylinder
	144	arrow
10	145	connector
	146	bracket
	147	ell shaped portion
	148	sleeve
	149	sleeve opening
15	150	bolted connection
	151	hydraulic rotary driver
	152	drive tool
	153	squared opening
	154	fold
20	155	connection
	156	bolted connection
	157	square drive
	158	

The foregoing embodiments are presented by way of  
25 example only; the scope of the present invention is to be  
limited only by the following claims.